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10/523,070	08/11/2005	Hiroshi Yagi	265011US2PCT	8376
22850	7590	05/04/2009		
OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, P.C. 1940 DUKE STREET ALEXANDRIA, VA 22314			EXAMINER HAN, SHENG	
			ART UNIT 1793	PAPER NUMBER
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

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<b>Office Action Summary</b>	<b>Application No.</b> 10/523,070	<b>Applicant(s)</b> YAGI ET AL.	
	<b>Examiner</b> SHENG HAN	<b>Art Unit</b> 1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-22 and 24-58 is/are pending in the application.
- 4a) Of the above claim(s) 9-17, 19-22, 24-29, 36-52, 55, 56 and 58 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6, 18, 30, 31-35, 53, 54 and 57 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                       | 5) <input type="checkbox"/> Notice of Informal Patent Application                       |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)<br>Paper No(s)/Mail Date ____. | 6) <input type="checkbox"/> Other: ____.  |

## **DETAILED ACTION**

### ***Response to Arguments***

1. Applicant's arguments with respect to claims 1-8, 18, 30, 31-35, 53, 54, and 57 have been considered but are moot in view of the new ground(s) of rejection.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

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consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 2, 8, 18 and 54 rejected under 35 U.S.C. 103(a) as being unpatentable over Schuppich (7247276) in view of Matsubayashi et al (US 6,103,411). Schuppich teaches a microreactor for obtaining hydrogen gas (col. 8, lines 10-11) comprising a metal substrate (col. 10, line 53, nickel-copper alloy) having a microchannel portion on one surface thereof (Fig. 1, 1), a heater provided on the other surface of the metal substrate (col. 5, lines 57-58, fluid guidance plate can be cooled or heated on its rear side), via an insulating film (Fig. 2, 23), a catalyst supported on said microchannel portion (col. 7, line 5-7, catalyst is applied by coating), and a cover member (Fig. 2, 12 and col. 3, line 53, top plate) having a feed material inlet (col. 5, lines 60-64) and a gas outlet (col. 5, line 64). Schuppich teaches that the cover member having a feed material inlet (Fig 3, inlet) and a gas outlet (Fig. 3, outlet) are joined to the metal substrate so as to cover the microchannel portion.

Shuppich teaches that the heater element is provided on one side of the microchannels, but does not specifically teach that the heater element is on the side where the microchannel portion is not formed. Shuppich also does not distinctly teach that there is a single continuous flow path where the feed material inlet and the gas outlet are substantially perpendicular to axial directions of the single continuous flow path.

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Matsubayashi et al (US 6,103,411) discloses a hydrogen production apparatus by reacting a fuel in a reactor system (abstract). This reactor system comprises channels that weave across the plate (Fig. 4) from inlets that run perpendicular to the weaving channels (Fig. 4 and col. 9, lines 1-4). As Matsubayashi demonstrates in the figures (Fig. 4), these channels are facing upwards. Below the layers of channels are two heat sources for the reaction. The first stems from the anode and cathode underneath the layers (Fig. 3, anode and cathode units). The second comes from the burner (Fig. 1, 42) which is attached to the reformer (col. 1, lines 17-30). The burner burns the fuel and provides heat to the reformer.

Since the channels are heated in Schuppich, it would have been obvious to one of ordinary skill in the art at the time of the invention to heat the channels on the outersurface, as taught by Matsubayashi, with the system as described by Shuppich in order to allow the stream to further react with other compositions on the channel surface.

Furthermore, it would have been further obvious to one of ordinary skill in the art at the time of the invention to incorporate a flow path with has inlet and outlets perpendicular to the single continuous flow path, as taught by Matsubayashi with the system as described by Shuppich because it is one known method of reacting the fuel in this known system.

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Regarding Claim 2, Schuppich teaches use of a nickel-copper alloy (col. 10, line 53).

Claims 3, 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schuppich in view of Matsubayashi, as applied to Claim 1, and further in view of Thies (6736983).

Schuppich teaches a microreactor capable of obtaining hydrogen gas (col. 8, lines 10-11) comprising a metal substrate (col. 10, line 53, nickel-copper alloy) having a microchannel portion on one surface thereof (Fig. 1, 1), a heater provided on the other surface of the metal substrate (col. 5, lines 57-58, fluid guidance plate can be cooled or heated on its rear side), via an insulating film (Fig. 2, 23), a catalyst supported on said microchannel portion (col. 7, line 5-7, catalyst is applied by coating), and a cover member (Fig. 2, 12 and col. 3, line 53, top plate) having a feed material inlet (col. 5, lines 60-64) and a gas outlet (col. 5, line 64). Schuppich teaches that the cover member having a feed material inlet (Fig 3, inlet) and a gas outlet (Fig. 3, outlet) are joined to the metal substrate so as to cover the microchannel portion. Schuppich does not teach that the insulating film is a metal oxide film formed by anodically oxidizing said metal substrate or the use of an Aluminum substrate however. Schuppich teaches use of a nickel copper alloy (col. 10, line 53). Thies teaches a microreactor for obtaining hydrogen gas (col. 1, line 8) characterized by comprising a metal substrate (col. 2, lines 5-6, steel plates, col. 3, line 7 and col. 3, lines 20-22 metal substrate layers) and having a microchannel portion on one surface thereon (Fig. 1, b, b', c and c'). The reference

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discloses that a catalyst can be placed on the microchannel portion of the substrate (col. 7, line 12 and col. 7, line 24). Thies discloses a cover member (Fig. 4, a, c, layer 2 and col. 6, line 46-49). Furthermore, Thies teaches that steel, copper or aluminum can be used as a substrate (metal layer, col. 6, line 21 or col. 6, line 21 or 37). Thies also teaches the formation of a metal oxide layer by anodically oxidizing the metal substrate (col. 7, lines 18-20, where the substrate is aluminum and the aluminum is oxidized with an acid). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the aluminum substrate, as taught by Thies, to the microreactor, as taught by Schuppich because to substitute one known element with high thermal conductivity for another known element with high thermal conductivity used to perform the same function of conducting heat would yield predictable results and therefore be obvious. Furthermore, it would have been obvious to one of ordinary skill in the art at the time of the invention to oxidize the substrate, as taught by Thies, with the microreactor, as taught by Schuppich because oxide layers can carry catalysts and facilitate a composition's reaction with such catalyst.

With Regard to Claim 4, Thies teaches that the metal oxide film is provided in said microchannel portion (col. 7, lines 17-27).

Claims 18, 30, 31, 33, 34, 35, 53 and Claim 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kearl (6828055) and further in view of Bae (2002/0169077) and Matsubayashi (US 6,103,411)

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Kearl teaches a microreactor that generates hydrogen gas (col. 8, lines 5-6 and 17, catalyst can be used to accelerate the conversion of hydrocarbons and alcohols to hydrogen), comprising a metal substrate (col. 7, lines 34-35, coated with a precious metal), having a microchannel portion on one surface thereof (Fig. 1), a heater provided on the other surface of said metal substrate (Fig. 2B, 30 and 32 anode and cathode, which generate heat Fig. 2B, 24 and 26 are under substrate and claim 11, second face adopted to contact a cathode of a second fuel cell and Claim 16, resistive element adopted to heat the substrate, Fig. 2B, 14, microchannel, 16, back of substrate col. 12, lines 17-18, Fig. 2B, 30 and 32 are electrodes that heat substrate). Between the metal substrate and the heater (electrode) is a thin film insulating layer (col. 10, line 30, resistive element that may be a thin film resistive element), a catalyst supported on said microchannel portion (col. 9, lines 55-56, catalyst is coated in microchannels, Fig. 7, 5 and Fig. 12, 50), a cover member joined to said metal substrate so as to cover said microchannel portion (Fig. 2A, microchannels layered on top of one another so that the backs of each microchannel is the cover member and Fig. 2A, 66 is another cover member). Finally, Kearl teaches an inlet and an outlet (Fig. 8, Fig. 7, 46, 50) which are both capable of supplying feed material in and gas out. Kearl does not teach forming a metal oxide film on an inner wall surface of said flow path however. Bae teaches a microreactor that has microchannels and a catalyst layer. Bae further discloses forming a metal oxide film on an inner wall surface of said flow path (para. 0032, use of an oxidizable metal substrate such as nickel, copper, iron or cobalt, with an oxide ion conductor). It would have been obvious to one of ordinary skill in the art at the time of



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the invention to use a metal substrate, as taught by Bae, to the microreactor, as taught by Kearl because copper has a higher thermal conductivity than platinum.<sup>1</sup> Therefore, it would take less heat and energy for the substrate to conduct copper is much more inexpensive than platinum. With regard to the substrate being oxidized, it is known that a metal substrate in a fuel cell is prone to oxidation over time and heat, and therefore it is also inherent that the substrate would be oxidized.

Kearl and Bae teach that the heater element is provided on one side of the microchannels, but does not specifically teach that the heater element is on the side where the microchannel portion is not formed. Kearl also does not distinctly teach that there is a single continuous flow path where the feed material inlet and the gas outlet are substantially perpendicular to axial directions of the single continuous flow path.

Matsubayashi et al (US 6,103,411) disclosed a hydrogen production apparatus by reacting a fuel in a reactor system (abstract). This reactor system comprises channels that weave across the plate (Fig. 4) from inlets that run perpendicular to the weaving channels (Fig. 4 and col. 9, lines 1-4). As Matsubayashi demonstrates in the figures (Fig. 4), these channels are facing upwards. Below the layers of channels are two heat sources for the reaction. The first stems from the anode and cathode underneath the layers (Fig. 3, anode and cathode units). The second comes from the burner (Fig. 1, 42) which is attached to the reformer (col. 1, lines 17-30). The burner burns the fuel and provides heat to the reformer.

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<sup>1</sup> Sanchez (2008/0142036), paragraph 0055.

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Since the channels are heated in Kearn and Bae, it would have been obvious to one of ordinary skill in the art at the time of the invention to heat the channels on the outersurface, as taught by Matsubayashi, with the system as described by Kearn and Bae in order to allow the stream to further react with other compositions on the channel surface.

Furthermore, it would have been further obvious to one of ordinary skill in the art at the time of the invention to incorporate a flow path with has inlet and outlets perpendicular to the single continuous flow path, as taught by Matsubayashi with the system as described by Kearn and Bae because it is one known method of reacting the fuel in this known system.

Regarding Claim 33, Kearn teaches that the microchannels are U-shaped or semi-circular (Fig. 8).

Regarding Claim 34, Kearn teaches coating the metal substrate with a catalyst using different methods such as spin coating, dip coating or dry film laminating (col.12, line 57), but does not specifically teach that the catalyst is dried in the microchannels. Bae teaches a microchannel with flow channels (para. 0005), where the slurry of catalyst is allowed to dry on the susbstrate (para. 0012, para. 0026 using the tape casting method and para. 0027).

Regarding Claim 35, Kearn teaches that catalyst can be applied using spin casting (para. 0012). Bae further teaches that the catalyst can be applied using spin coating (col. 12, line 57).

Regarding Claims 53 and 54, Kearn, Bae and Matsubayashi teach a reactor as described by the rejection to Claims 1, 18 and 30, but does not teach use of a cover to the microreactor. It would have been obvious to one of ordinary skill in the art at the time of the invention to use a lid or housing to protect the reactor from being contaminated, reacting when idle or from other damage to the system.

Regarding Claim 57, Kearn teaches a microreactor that generates hydrogen gas (col. 8, lines 5-6 and 17, catalyst can be used to accelerate the conversion of hydrocarbons and alcohols to hydrogen), comprising a metal substrate (col. 7, lines 34-35, coated with a precious metal), having a microchannel portion on one surface thereof (Fig. 1), a heater provided on the other surface of said metal substrate (Fig. 2B, 30 and 32 anode and cathode, which generate heat Fig. 2B, 24 and 26 are under substrate and claim 11, second face adopted to contact a cathode of a second fuel cell and Claim 16, resistive element adopted to heat the substrate, Fig. 2B, 14, microchannel, 16, back of substrate col. 12, lines 17-18, Fig. 2B, 30 and 32 are electrodes that heat substrate). Between the metal substrate and the heater (electrode) is a thin film insulating layer (col. 10, line 30, resistive element that may be a thin film resistive element), a catalyst

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supported on said microchannel portion (col. 9, lines 55-56, catalyst is coated in microchannels, Fig. 7, 5 and Fig.12, 50), a cover member joined to said metal substrate so as to cover said microchannel portion (Fig. 2A, microchannels layered on top of one another so that the backs of each microchannel is the cover member and Fig. 2A, 66 is another cover member). Finally, Kearl teaches an inlet and an outlet (Fig. 8, Fig. 7, 46, 50) which are both capable of supplying feed material in and gas out. Kearl does not teach forming a metal oxide film on an inner wall surface of said flow path however. Bae teaches a microreactor that has microchannels and a catalyst layer. Bae further discloses forming a metal oxide film on an inner wall surface of said flow path (para. 0032, use of an oxidizable metal substrate such as nickel, copper, iron or cobalt, with an oxide ion conductor). It would have been obvious to one of ordinary skill in the art at the time of the invention to use a metal substrate, as taught by Bae, to the microreactor, as taught by Kearl because copper has a higher thermal conductivity than platinum.<sup>2</sup> Therefore, it would take less heat and energy for the substrate to conduct copper is much more inexpensive than platinum. With regard to the substrate being oxidized, it is known that a metal substrate in a fuel cell is prone to oxidation over time and heat, and therefore it is also inherent that the substrate would be oxidized.

Kearl and Bae teach that the heater element is provided on one side of the microchannels, but does not specifically teach that the heater element is on the side where the microchannel portion is not formed. Kearl also does not distinctly teach that

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<sup>2</sup> Sanchez (2008/0142036), paragraph 0055.

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there is a single continuous flow path where the feed material inlet and the gas outlet are substantially perpendicular to axial directions of the single continuous flow path.

Matsubayashi et al (US 6,103,411) disclosed a hydrogen production apparatus by reacting a fuel in a reactor system (abstract). This reactor system comprises channels that weave across the plate (Fig. 4) from inlets that run perpendicular to the weaving channels (Fig. 4 and col. 9, lines 1-4). As Matsubayashi demonstrates in the figures (Fig. 4), these channels are facing upwards. Below the layers of channels are two heat sources for the reaction. The first stems from the anode and cathode underneath the layers (Fig. 3, anode and cathode units). The second comes from the burner (Fig. 1, 42) which is attached to the reformer (col. 1, lines 17-30). The burner burns the fuel and provides heat to the reformer.

Since the channels are heated in Kearn and Bae, it would have been obvious to one of ordinary skill in the art at the time of the invention to heat the channels on the outersurface, as taught by Matsubayashi, with the system as described by Kearn and Bae in order to allow the stream to further react with other compositions on the channel surface.

Furthermore, it would have been further obvious to one of ordinary skill in the art at the time of the invention to incorporate a flow path with has inlet and outlets perpendicular to the single continuous flow path, as taught by Matsubayashi with the system as described by Kearn and Bae because it is one known method of reacting the fuel in this known system.

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Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over as being unpatentable over Kearl (6828055), Bae (2002/0169077) and Matsubayashi as applied to Claim 30, and further in view of Lambert (5139648). Kearl, Bae and Matsubayashi teach a microreactor that generates hydrogen gas (col. 8, lines 5-6 and 17, catalyst can be used to accelerate the conversion of hydrocarbons and alcohols to hydrogen), comprising a metal substrate (col. 7, lines 34-35, coated with a precious metal), having a microchannel portion on one surface thereof (Fig. 1), a heater provided on the other surface of said metal substrate (Fig. 2B, 30 and 32 anode and cathode, which generate heat Fig. 2B, 24 and 26 are under substrate and claim 11), but do not teach use of boehmite. Kearl does disclose a surface processing step of forming a metal oxide film on an inner wall surface of said flow path (col. 12, lines 51-57) and a catalyst applying step of applying a catalyst to the inner wall surface of said flow path via said metal oxide film (col. 12, lines 39-46, nickel is a catalyst in col. 8, line 20). Moreover, Bae teaches use of alumina (para. 0032, or aluminum oxide). Boehmite is aluminum oxide hydroxide, or  $\text{AlO}(\text{OH})$ . Lambert teaches that boehmite can be used instead of alumina (para. 0081). It would have been obvious to one of ordinary skill in the art at the time of the invention to use boehmite, as taught by Lambert, with the microreactor, as taught by Kearl and Bae because Lambert teaches that boehmite could be used instead of aluminum oxide and that they are potential substitutes of one another. It would further have been obvious to one of ordinary skill in the art at the time of the invention that the alumina would likely become further oxidized under the heated conditions of the

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microreactor, hydrogen gas being generated and oxygen ions, so that a hydroxyl group would be added to the oxidized alumina.

Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over as being unpatentable over Kearl (6828055) and Bae (2002/0169077) and Matsubayashi as applied to Claim 30, and further in view of Wang (2003/0116503). Kearl, Bae and Matsubayashi teach a microreactor that generates hydrogen gas (col. 8, lines 5-6 and 17, catalyst can be used to accelerate the conversion of hydrocarbons and alcohols to hydrogen), comprising a metal substrate (col. 7, lines 34-35, coated with a precious metal), having a microchannel portion on one surface thereof (Fig. 1), a heater provided on the other surface of said metal substrate (Fig. 2B, 30 and 32 anode and cathode, which generate heat Fig. 2B, 24 and 26 are under substrate and claim 11), but do not teach use of boehmite. Wang teaches a microreactor with channels, a metal substrate and a catalyst. Wang further teaches the use of alumina/alumina oxide layer (para. 0046, and 0041). Wang does not specifically teach use of boehmite, however, it would have been obvious to one of ordinary skill in the art at the time of the invention that oxidation of the alumina catalyst in addition to heat, hydrogen and oxygen in the system would result in further oxidation of the alumina, resulting in boehmite.

***Conclusion***

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SHENG HAN whose telephone number is (571)270-5823. The examiner can normally be reached on Monday-Thursday, 8:00-5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Melvin Curtis Mayes can be reached on 571-272-1234. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.



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Sheng Han  
Examiner  
Art Unit 1793

SH  
April 24, 2009

/Melvin Curtis Mayes/  
Supervisory Patent Examiner, Art Unit 1793